Dialect Variation, Multiple Measures of Inhibition, and Collective-Distributive Quantifier Interpretation

Research Thesis

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by

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Description of the Phenomenon

In what follows, we will review the existing literature on collective and distributive interpretations in children. The consistent pattern we will observe is that distributivity is a relatively late acquisition, culminating at around 11 years of age, across child languages. The more recent work on the topic has further shown that collective interpretations emerge around the same time and in a linked way. After reviewing what has been said in the developmental semantic literature, we will review a prominent model of executive function abilities and describe our three executive function tasks that measure inhibition. We will then consider the impact of executive function on adult sentential interpretations and review what little work exists on the interaction of sentential interpretations and executive function in children. Then, we will review dialectal variation in children and its relation to language development. Finally, we will see results from our three experiments on inhibition, our Truth-Value Judgment Task of collective-distributive interpretations and consider the relationships among them.

Collective-Distributive Interpretations in Child Language

Grice (1975)

In this foundational paper, H. P. Grice summarizes various aspects of conversational speech. He groups together maxims of speech into four different categories: Quantity, Quality, Relation, and Manner. Grice claims that a rule of conduct under Quantity is “Make your contribution as informative as required, but not too informative,” under Quality is “Do not say anything you think is false or don’t have evidence for,” under Relation is simply “Be relevant,” and under Manner is “Be clear and understandable.” Grice states that when these maxims are broken or are deviated from, the listener must make observations and assumptions to determine what the speaker is trying to say in their conversation; this is the idea of implicatures. Grice states that conversational implicatures are common in most conversations and often easily deciphered by listeners. An example of a conversational implicature is the quantity implicature associated with the existential quantifier *some* in English. When a speaker says, "I ate some cookies" it can have the truth-conditional meaning that there exists a plural number of cookies that I ate, which is the "some, and possibly all" interpretation, or it can have the pragmatically enriched meaning, via the conversational implicature, that I ate "some, but not all" of a set of cookies under consideration. In this way, the position of *some* on the quantity scale of quantifiers {all, every, each….most, many…some, two, few, none} determines that it should be used to not mean *all,* because *all* is already present on the scale. These implicatures are what must develop as children age and are what we focus on in this study.

Hanlon (1986)

In one of the earliest studies to note children's struggle to interpret distributive quantifiers, Camille C. Hanlon conducted an experiment on how children learning American English as a first language use quantifiers, such as *all, some, none, each,* etc. and demonstrated the pattern that we will see replicated across the literature. By analyzing the cognitive development of the children in her study and comparing it with a model based on adult usage of quantifiers, Hanlon was able to predict generally when children learn how to use each quantifier. Hanlon tested 3 levels of generality: generic, specific, and nonspecific. She predicted nonspecific quantifiers would develop earlier than specific, which would develop earlier than generic. She also predicted that forms that were the same as the reference set would be used correctly earlier than forms that were a derivative of the reference set. By this, Hanlon means that *all* should be acquired earlier than *some, none, any, other* and *another*. Similarly, *both* is learned before *either* and *neither*, and *all* should be learned before *each* and *every*. The results of her study confirm these predictions. She also concluded that *all* develops before *some* and *none* and is semantically simpler than the other tested quantifiers.

With respect to the development of distributivity, Hanlon conducts two relevant experiments. In the first, children are given instructions such as *Put each letter in a box*, and in the second they are instructed to *Give him each of the cookies*, using a bowl of cookies to feed a Cookie Monster puppet. In both experiments, the distributive quantifier *each* was one of 10 quantifiers used, and, as illustrated in the following figure (from Hanlon 1986, p. 239, Table 7), *each* was the most difficult for all of the children, who were aged 3;0 – 7;11, to correctly interpret.

TABLE 7
Percent of 4- Through 7-Year-Old Children Passing Each Quantifier Comprehension Test in Each Task

Quantifier	Task: Letters	Task: Cookies
all	100	100
none	87	89
some	89	92
any	93	92
other	80	93
another	49	51
both	100	100
either	46	46
neither	31	43
each	31	3

Note. Pass = 2 out of 3 trials correct. N = 61.

Table 1: Percent of children, age 4 – 7 years, passing Hanlon's two tests (Hanlon, 1986, p. 239, Table 7)

This pattern of difficulty with distributive *each* is confirmed in subsequent work, as we will see.

Brooks and Braine (1996)

Similar to the study done by Hanlon, though narrower in scope, Brooks and Braine conducted three experiments testing children's understanding of the quantifiers *all* and *each*. In the first experiment, children's ability to restrict universal quantifiers was analyzed. Pictures depicting subject-exhaustive interpretations (with extra objects) and object-exhaustive interpretations (with extra subjects) were shown to them while a sentence was read. The children chose the correct answer often when the quantifier *all* was used, with little variation between the age groups. For the quantifier *each*, the researchers found that its position in the sentences was significant. In particular, *each* was interpreted as distributive earlier and more categorically in subject position (*Each X is [verb]ing a Y.)* than in direct object position (*There is an X [verb]ing each of the Ys.*). Younger children (ages 4-8) did not seem to use the position of *each* to interpret the sentence as distributive and selected the wrong picture more often than the older children (9-10 years old).

In the second experiment, the researchers tested the effects of active and passive voice on sentence interpretations by using the modifiers *all, each,* and *three*. They found voice was significant, in that when passive voice was used ("A boat is being built by all the men"), the collective interpretation was selected more often than distributive. Age was also significant in that more correct responses were selected as age increased. This suggests children do use lexical and syntactic cues to interpret sentences.

Lastly, the third experiment tested understanding of *each* and *all* with collective, distributive, and exhaustive depictions. Children selected the exhaustive interpretation more for sentences with two definite plural noun phrases, but overall selected the exhaustive interpretation less than adults, which indicated full understanding of the quantifier does not appear until later in development.

Figure 1: Example of exhaustive depiction used in Experiment 3

Overall, the researchers found that the restriction that *each* applies to distributive contexts only was slow to develop, compared to the collective interpretation of *all*. This is the central phenomenon of interest in this project.

Brooks, Braine, Jia & Da Graça Diaz (1998)

To build on their previous work, Brooks and Braine worked with Jia and de Graça Dias to perform a series of experiments comparing Mandarin, Portuguese, and English quantifiers (*each* and *some*) in children ages 4-9 and adults. They hypothesized young children have a system that allows them to distinguish between collective and distributive interpretations of sentences.

In the first two experiments in Mandarin and Portuguese, the amount of exhaustive interpretations increased with age but developed later than collective or distributive interpretations. Children's choices also became more consistent with age, as more children chose the collective and distributive quantifiers for their respective sentences more often in the older age groups.

In the English experiment, the researchers compared sentences with 'one' (*Each man pushed one rock.*) and an indefinite article (*Each man pushed a rock.*). They found that 'one' has a collective-promoting effect relative to 'a', meaning more sentences with *each* were interpreted as collective instead of distributive when 'one' was used in direct object position in the sentence. This suggests that because of the difference in quantifiers of English and Mandarin and Portuguese, English *each* is more tightly linked to distributive interpretations when it occurs with *a* (the indefinite article) in direct object position. This study confirms the cross-linguistic finding that distributive interpretations have a long, relatively late-developing learning trajectory.

Musolino (2009)

Using different types of quantifiers, in this experiment, Musolino was able to reach similar conclusions, with respect to distributive interpretations, as did the previous studies. Musolino researched how numerically quantified expressions (NQE) are interpreted by adults and children. He used a Truth Value Judgement Task with six different animations and a prerecorded voice saying, "I know, three boys are holding two balloons, am I right?" and "I know, three boys are holding each balloon, am I right?" The six different types of animations depicted either subject wide scope (SU), object wide scope (OBJ), each-all (EA), cumulative (CU), or two control false representations.

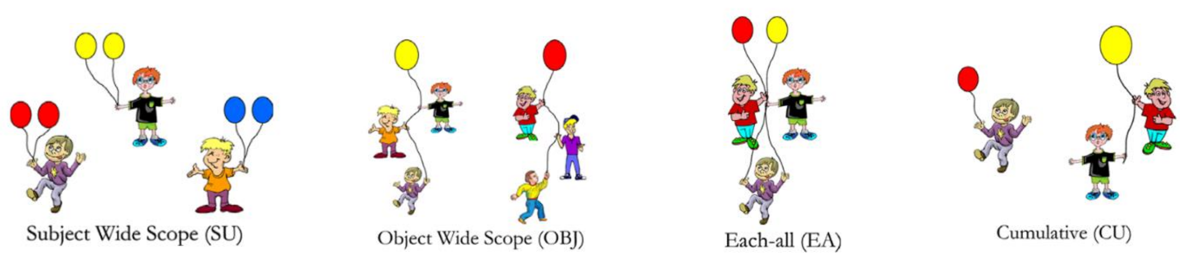

Figure 2: Subject wide scope, Object wide scope, Each-all, and Cumulative depictions

Musolino found that in the trials involving the *two balloon* statement, children responded in a more adult-like manner than they did in the trials involving the *each balloon* statement.

Children accepted the SU and CU interpretations significantly more than the adults did in the *each balloon* sentence. Musolino suggested this could be because *each* is a strong quantifier. For adults, strong quantifiers take scope over other quantifiers in a sentence, meaning even though the numerical quantifier *three* comes before *each* in the sentence *three boys are holding each balloon*, *each* takes precedence in the sentence. This is called quantifier raising. In other words, *each* is not interpreted based on its surface syntactic position, but rather is interpreted as if it were at the beginning of the sentence (i.e. *Each balloon is being held by three boys*.). Musolino states that when children hear the sentence *three boys are holding each balloon*, they focus on *three boys* as opposed to *each balloon* and will accept any interpretation in which each boy is holding a balloon.

While the focus of Musolino is the Isomorphism Effect (the observation that children do interpret quantifiers where they are in the sentence and not elsewhere) and its interaction with the quantifier *each*, there is nonetheless information related directly to the question of the development of the distributive interpretation of *each*, primarily in his control items. Consistent with the pattern noted in Hanlon (1986), Brooks & Braine (1996); Brooks, Braine, Jia & Da Graça Diaz (1998), children in the control items accept distributive sentences such as *Each boy is holding a balloon*. as characterizations of non-distributive pictures at much higher rates (85.1% vs 23.4%) than do adults, as in the following picture (Musolino 2009, p. 32, picture 6):

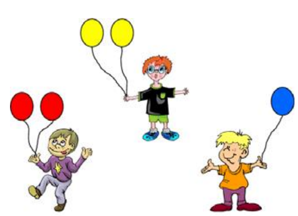
Control False 1

Figure 3: Image corresponding to control sentences presented with the quantifier *each* (Musolino, p. 32, picture 6)

In this way, 5-year-old English-speaking children show a delay in their development of the distributive restriction on the quantifier *each*.

Feeney et al. (2004)

In this study done by Feeney et al., several experiments were done looking exclusively at the quantifier *some*. They are relevant to our collective-distributive study because they looked at the interaction of executive function and scalar implicature interpretations, which is what we believe is occurring with collective-distributives as well. Feeney et al. studied the sensitivity of children and adults to the scalar implicature of the quantifier *some.* In their first experiment, the researchers recorded the responses of 7-8-year-old children and a group of adults to several statements. There were four true *all* statements (e.g. all cats have ears), four false *all* statements (e.g. all children are blonde), four felicitous *some* statements (e.g. some flowers are yellow), and four infelicitous *some* statements (e.g. some books have pages). Lastly, there were four absurd *all/some* statements (e.g. all chairs tell time). The number of logically correct responses, meaning responses interpreted without an extra implicature, was higher for *all* than *some,* and the mean logical response rate for infelicitous *some* statements was significantly lower than the other means. The researchers concluded that this result implied that both children and adults are sensitive to the scalar property of *some,* meaning the *some, but not all* interpretation.

In the second experiment, Feeney et al. were interested in studying whether sensitivity to scalar properties can increase with pragmatic contexts in children ages 7-8. They used a storyboard depicting a girl interacting with some or all of the objects pictured. Similar to experiment one, *all* true/false statements and *some* felicitous/infelicitous statements were used. The *all* false statements showed the girl interacting with only two out of the three objects pictured, and *some* infelicitous statements depicted the girl interacting with all the objects pictured. Fewer logical responses were given to infelicitous *some* statements compared to the other type of statements, which led Feeney et al. to conclude children can access the scalar implicature of *some* when statements are pragmatically rich.

Lastly, experiment three focused on undergraduate students' sensitivity to scalar implicatures. They used a counting span task, where participants were instructed to count the number of red dots on subsequent screens and recall the number of dots in the same order, to test working memory. In the second task, participants had to indicate whether sentences were true or false based on *all/some* absurd statements, *all* true/false statements, and *some* felicitous/infelicitous statements. The mean rate of logical responses was higher for true/felicitous statements than false/infelicitous statements. Additionally, the mean rate of logical responses to infelicitous *some* statements was significantly lower than felicitous *some*. Lastly, the mean response time for logical responses to infelicitous statements was significantly longer than the other response times, and memory span was positively correlated with these responses. Feeney et al. concluded the logical responses to infelicitous *some* were due to inhibition of the pragmatic responses.

The main conclusion of the authors from these experiments was that children's and adults' sensitivity to scalar implicatures of *some* are dependent on context and on the ability to inhibit the pragmatic responses. This conclusion is somewhat odd, as the authors did not employ a standard test of inhibition, such as Flanker, Continuous Performance, etc. Rather, they used a classic working memory task, Digit Span. Thus, while the most sensible interpretation of their results might be that working memory impacts implicature generation, our actual hypothesis is that inhibition does in fact also play such a role.

Syrett and Musolino (2013)

To further investigate the ability of children to access the distributive and collective interpretations of quantifiers, researchers Syrett & Musolino performed 5 different experiments to test young children's (4-5 years old) preference for and acceptance of collective and distributive interpretations of sentences. The first two experiments were a judgement task and a preference task with ambiguous sentences. In the judgement task, videos were shown, and a sentence was played describing the scene. Both adults and children accepted the collective and distributive interpretations of each sentence, as was expected because of the ambiguity of each sentence. In the acceptance task, participants were shown two pictures and asked which picture better fit a sentence, such as "Two boys pushed a car." Musolino and Syrett found that adults preferred the collective interpretation over the distributive interpretation most of the time, while children showed no preference an accepted both. In the second experiment, a preference task, children accepted *Two boys pushed a car* in distributive contexts (68.5%) and less so in collective contexts (31.5%), while adults showed the opposite pattern. The third experiment was a judgement task with passive sentences such as "A car was pushed by two boys" to see if children could access the collective interpretation of a sentence. Adults accepted collective 100% of the time, whereas children accepted the collective sentence 85% of the time. Also, adults only accepted the distributive interpretation 23.6% of the time, but children accepted it 66.7% of the time, consistent with the delayed development of the distributive interpretation that we have seen in previous work. The fourth experiment was a judgement task with additional lexical items, *each* and *together.* The sentences were modelled on "Two boys each pushed a car," and "Two boys pushed a car together." Adults accepted *each* as distributive and *together* as collective. Children generally accepted sentences in both contexts, but *together* as collective slightly more than distributive. The last experiment was a preference task with *together* to see if children can access the collective distribution of *together*, and they found they could.

This research further supports the difficulty children seem to have identifying the distributive interpretation of the quantifier *each* and the lack of distinction they have between collective and distributive interpretations of various quantifiers. They do not discriminate between the two as much as adults do.

Pagliarini, Fiorin & Dotlačil (2012)

The first study to demonstrate a mathematical connection between collective and distributive interpretations in the same sample of children is Pagliarini et al. The authors test collective and distributive interpretations of sentences containing definite plural noun phrases and the distributive quantifier *each* in a large, cross-sectional sample of Italian children aged 4-13. The authors follow Dotlačil's (2010) proposal that natural language quantifiers fall onto a distributive-collective pragmatic scale in the lexicon, which is anchored at the distributive end by the entailment of *each.* On this account, the collective quantifiers (e.g. *some* and *the*) derive their collective meaning by virtue of being ambiguously collective or distributive, but in a lexicon that includes the distributive entailment of *each*, they take on a consistently collective meaning in the adult language, as a function of Gricean informativeness (Grice 1975).

The authors used what they refer to as a Truth Value Judgement Task, however, instead of playing either live action or video-recorded action scenarios for the participants, they showed the participants a static picture and asked if the spoken sentence was correct or incorrect. There were four conditions. Condition A and Condition C both involved pictures with a distributive action being depicted. Condition A used sentences like A. *Each girl is building a sandcastle,* whereas Condition C used sentences like C. *The girls are building a snowman.* Conditions B and D involved pictures depicting a collective action with the sentences B. *Each boy is building a snowman* and D. *The boys are building a castle*, respectively. Pagliarini et al. predicted that rejecting the distributive interpretations of sentences with noun phrases with “the” (*i* or *le* in Italian) should develop after the acquisition of *each*. They also predicted that for kids, the rejection of sentences with *each* in collective contexts will predict whether they reject the distributive interpretation of sentences with *i* in subject position. They found both predictions to be true. Children ages 4 and 5 accepted the collective interpretation of *each* up until the age of 11. Additionally, children did not start rejecting the distributive interpretation of definite plural noun phrases until ages 9 and 10, some even up until 13. This suggests that the understanding of distributive quantifiers develops before definite plurals. Lastly, a strong positive correlation was found between Conditions B and C, meaning responses to Condition B (rejecting *ciascun*, or *each,* in collective contexts) were predictive of responses to C (rejecting definite plural subjects in distributive contexts), which is consistent with Dotlačil’s hypothesis that the collective and distributive quantifiers form pragmatic scale in the lexicon.

The following table (Table 2 from Pagliarini et al. 2012, p. 8) illustrates the contingency between rejection of *each* in collective contexts (Condition B) and the rejection of *the* in distributive contexts (Condition C).

	Proportion of 'true' answers			
Group	Cond. A	Cond. B	Cond. C	Cond. D
4YO	96 (8)	89 (25)	96 (10)	93 (11)
5YO	100 (0)	92 (23)	99 (4)	97 (7)
6YO	98 (6)	81 (34)	98 (6)	99 (4)
7YO	100 (0)	67 (45)	99 (4)	100 (0)
8YO	100 (0)	49 (46)	95 (18)	100 (0)
9YO	100 (0)	39 (42)	92 (15)	96 (10)
10YO	100 (0)	26 (33)	88 (24)	98 (5)
11YO	100 (0)	10 (27)	76 (24)	98 (6)
12YO	98 (6)	11 (22)	71 (29)	100 (0)
13YO	99 (3)	11 (19)	72 (30)	98 (5)
AD	96 (10)	9 (18)	50 (32)	98 (13)

Table 2: Table 2 from Pagliarini et al. (2012, p. 8) illustrating the contingency between Conditions B (distributive *ciascun* in collective contexts) and Condition C (collective *i* in distributive contexts)

Interestingly, the bottom line of the Condition C column gives the adult results and suggests that adult Italian speakers interpret plural definite noun phrases in subject position as collective only 50% of the time. Given our previous literature, including Syrett & Musolino (2013), this result seems curious. It could be that Italian simply has different grammar from English in this regard, or it could be that the fact that the TVJT used a static picture instead of an acted-out scenario proved more taxing for adults.

Padilla-Reyes, Grinstead, Nieves-Rivera & González-Bonilla (2015)

In this follow-up study to Pagliarini et al., the authors test whether the same connection between collective and distributive sentences obtained in a Spanish-speaking cross-sectional sample, as was found in child Italian. The experimental format chosen, however, was a stop-motion, video-recorded Truth-Value Judgment Task, and did not use static pictures. The sample was cross-sectional and spanned 5- to 10-year-old monolingual Puerto Rican Spanish-speaking children, along with a sample of adults. Confirming the suspicion that Pagliarini et al.'s task may have been problematic, adult Spanish-speaker were found to be entirely categorical in their interpretations of collective sentences in distributive contexts, which is to say near 100% rejection, in contrast to Pagliarini et al.'s reported 50% rejection rate. As in Pagliarini et al., children's collective and distributive interpretations were highly correlated and were predicted by a receptive measure of Spanish lexical development, the Test de Vocabulario en Imágenes Peabody (TVIP – Dunn, Lugo, Padilla & Dunn 1986).

Oates (2017)

Given the apparent sensitivity in previous work of executive function for sentence interpretation, and given the apparent connection between collective and distributive interpretations in Pagliarini et al. and Padilla-Reyes et al., Oates set out to test 1) whether adult English collective and distributive interpretations of *some*, *the*, and, *each* are categorical in their interpretations, as in Spanish (though possibly not in Italian), 2) whether child English speakers' collective and distributive interpretations correlate, as in child Spanish, and 3) whether tests of executive function can be predictive of developing collective and distributive interpretations in Spanish. In the first experiment, English-speaking adults were given various tasks to perform from the EXAMINER battery that tested inhibition, attention, and working memory, as well as a TVJT portraying minions (from the movie *Despicable Me*) involved in collective or distributive activities. Oates found that English-speaking adults categorically accepted *each* in distributive contexts and similarly that they accepted *some* and *the* categorically in collective contexts. This answered the first research question in that English-speaking adults do follow the same pattern as Spanish-speaking adults in their interpretations of the quantifiers. With respect to the second question, collective and distributive interpretations were in fact correlated in the 7-9-year-old child English sample. These interpretations were also predicted by the general lexical measure of child English, the Peabody Picture Vocabulary Test (Dunn & Dunn 2010).

In the second experiment, Spanish-speaking children ages 7-9 were also given the EXAMINER tasks, including Set-Shifting for attention, Dot Counting for working memory and Flanker for Inhibition, along with the TVJT, and the PPVT, a standardized vocabulary test. The children accepted *cada* in collective contexts 48.5% of the time and 93.5% of the time in distributive. They accepted *unos* as distributive 44.1% of the time and 93.5% as collective, and *los* as collective 96.8% of the time and 43.5% as distributive.

The third experiment was the same as the above, but with English-speaking children ages 7-9. The children accepted *each* as collective 24.7% of the time, but as distributive 91.9% of the time. They accepted *some* 90.2% and 30.4% of the time in collective and distributive contexts respectively. Lastly, the children accepted *the* 95.4% and 33.9% of the time in collective and distributive contexts respectively.

All these results demonstrate that children accept these three quantifiers in both collective and distributive contexts more often than adults do. More importantly, Oates concluded that lexical development was a strong predictor of children's ability to reject *cada* and *each* in the collective context, *unos/some* in the distributive context, and *los/the* in the distributive context. Attention was a good predictor for the ability to reject *cada/each* in the collective context, which Oates suggests might be because of the differences between the Spanish and English indefinite quantifiers. The Spanish indefinite quantifier also means the numeral *one*, so Oates suggests Spanish-speaking children must pay more attention to correctly interpret a sentence compared to English-speaking children.

As with many of the other research experiments we have looked at, this experiment demonstrates that children do not behave the same way as adults do in interpreting distributive and collective quantifiers, especially the quantifier *each.* In follow-up work, Grinstead, Oates, Nieves-Rivera & Padilla Reyes (under submission) reanalyze Oates' data as a count distribution and find that not attention, but rather inhibition, is predictive of children's judgments. This makes sense in that the *unos/some* and *los/the* interpretations were predicted, but not the *cada/each* judgments. While *cada/each* is the result of a semantic entailment, and unambiguous, both *unos/some* and *los/the* are potentially ambiguous between collective and distributive interpretations, which makes inhibition of the irrelevant interpretation an important factor in generating an interpretation.

Concluding our review of the literature on collective and distributive interpretations, we can see that across languages they are a late development and that this development appears to be predicted by both lexical development and by executive function development, including at least inhibition, as measured by the Flanker Task. Given the sensitivity of inhibition to collective-distributive interpretations, we now turn to a consideration of executive function and, in particular, measures of inhibition.

Executive Function and Inhibition

Miyake et al. (2000)

Miyake et al. (2000) has been a very influential study in the field of executive function. The authors conducted a latent variable analysis of three executive function abilities (Shifting, Updating, and Inhibition) with 137 undergraduates. They administered three tasks for each category, as well as five complex executive tasks. The first shifting task was the plus-minus task, in which participants were instructed to either add three, subtract three, or alternate between adding and subtracting three to lists of numbers. The second task was the number-letter task, and the last shifting task was the local-global task.

One of the updating tasks was the keep track task. Participants had to keep track of the last word of different categories as they were shown in succession. Another updating task, the tone monitoring task, required participants to press a button when they heard a tone from the same category four times. Lastly, the letter memory task involved a sequence of letters being displayed in sequence, and participants had to say out loud the last four letters as the sequence continued.

Of greatest relevance to my project, there were three tasks applied that measured inhibition. They were the Anti-Saccade Task, the Stop-Signal Task, and the Stroop task. In the anti-saccade task, participants had to ignore a visual stimulus on one side of the screen and focus on the visual stimulus, an arrow, on the other side of the screen and indicate which direction the arrow was pointing. For the Stop-signal task, participants categorized words as they popped up on the screen in the first trial, but in the second trial, participants were instructed to not respond to words that popped up with a computer emitted tone. Finally, in the Stroop task, participants had to say the color of the color word on the screen. In one trial, the color word was the same as the color of the stimulus, but in the other trial, the color word was a different color.

In Miyake's design, the objective was first, to see if each of the tasks corresponding to one of the three hypothesized executive function abilities loaded on a single factor, and if so, to what degree. Second, the latent variables that emerged for each factor, arising from the variance common to the three relevant tasks, were put into a further latent variable regression, or structured equation model, to determine the degree to which they could predict variance relevant to them, in tasks that hypothetically involved a combination of all three executive function abilities. The five complex executive tasks were the Wisconsin Card Sorting Task, the Tower of Hanoi, random number generator, operation span task, and the dual task.

Miyake et al. found that a three-factor model was the best model to explain the correlation between updating, shifting, and inhibition, meaning the three factors are independent of each other. The three factors did have relatively high levels of correlation, so even though they are independent of each other, Miyake et al. concluded they are related. Additionally, by using a latent variable analysis, the researchers were able to lessen the task impurity problem by finding common factors across all of the tasks.

Because my project is specifically concerned with the relationship among distinct measures of inhibition, it is interesting to note the reported significant correlations among Miyake et al.'s three measures, which I report in the following table.

APPENDIX A

Pearson Correlation Coefficients for the 15 Measures (N = 137 Unless Noted)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Plus–minus	—														
2. Number–letter	.32*	—													
3. Local–global	.23*	.32*	—												
4. Keep track	.23*	.08	.12	—											
5. Tone monitoring	.22*	.19*	.00	.15	—										
6. Letter memory	.24*	.11	.21*	.34*	.27*	—									
7. Antisaccade	.15	.17	.11	.12	.26*	.22*	—								
8. Stop-signal	.11	.13	.06	.10	.09	.04	.19*	—							
9. Stroop	.07	.09	−0.05	.11	.16	.18*	.20*	.18*	—						
10. WCST perseveration[a]	.26*	.13	.18*	.09	.19*	.14	.15	−0.01	.10	—					
11. TOH[b]	.08	.10	−0.09	.13	.18*	.14	.21*	.08	.17	−0.02	—				
12. RNG Component 1	.20*	.13	.01	.03	.11	.19*	.24*	.12	.11	.13	.10	—			
13. RNG Component 2	.20*	−0.07	.07	.29*	.06	.19*	.02	.18*	.01	−0.08	.12	.02	—		
14. Operation span	.09	.08	−0.04	.41*	.28*	.34*	.16	.13	.20*	.16	.04	.17*	.13	—	
15. Dual task[a]	−0.03	−0.02	.05	−0.09	−0.03	.12	−0.08	−0.16	.06	.06	−0.18*	−0.05	−0.09	−0.14	—

Note. WCST, Wisconsin Card Sorting Test; TOH, Tower of Hanoi; RNG, random number generation.

[a] $N = 134$.

[b] $N = 136$.

* $p < .05$.

Table 3: Pearson correlation coefficients for all 15 measures (Miyake, 2000, p. 93, appendix A)

Rosvold et al. (1956)

One of the tasks I use in my study to test inhibition is the Continuous Performance Task. Rosvold et al. were one of the first researchers to conduct a Continuous Performance Task and, in "A Continuous Performance Test of Brain Damage," describe the results of a study done using a new instrument designed to identify impaired brain activity. The experimenters created a Continuous Performance Test (CPT) device that consisted of a revolving drum with rows of letters on it. The first test was the X task, in which the subjects were told to push a button when they saw the letter 'X'. The second task was the AX task, in which subjects were instructed to hit a button only when they saw the letter 'X' after an 'A'. The researchers had three groups of subjects: Defectives, Children, and Adults, and each of these was divided into two subgroups: brain-damaged and non-brain-damaged. The results of the study found that the brain-damaged subjects did significantly worse on the X and AX tasks than the non-brain-damaged subjects in all the experimental groups. The differences between the two subgroups were higher for the AX task than the X task, likely because the AX task was deemed more difficult than the X task. In terms of the effectiveness of the CPT apparatus, the researchers found that it was much more reliable in identifying the presence of brain damage rather than the absence of brain damage. They suggested that the CPT could be clinically useful in the diagnosis of brain damage.

With respect to the status of the task as a measure of the inhibition component of executive function, the CPT measures participants' abilities to not pay attention to letters that present themselves on the apparatus, and only pay attention to the letter or letters that they are instructed to attend to. Inhibition of the non-target letters, then, is analogous to other tasks, such as the Flanker Task of Eriksen & Eriksen (1974).

Eriksen and Eriksen (1974)

Eriksen and Eriksen conducted a study using a tool called the Flanker Task. This Flanker Task experiment tested a measure of inhibition, which consisted of measuring the effects that "noise", or distractor, letters had on subjects' abilities to identify a target letter. The researchers kept the target letter in the same location for each trial but had six different noise conditions: noise same as target, response compatible, response incompatible, heterogeneous- similar, heterogeneous- dissimilar, and target alone. Within each grouping of noise conditions, there were three different levels of spacings between the letters.

The results showed that effects of spacing and noise conditions were significant. As spacing between the letters increased, the reaction times decreased. When the spacing between the letters was the smallest, there was the most variability in reaction times, whereas the largest spacing had the most congruent results. The fastest reaction times were recorded when the noise letters were identical to the target. The dissimilar-noise condition had longer reaction times than the similar-noise condition. Trials run with noise of the opposite response set increased errors and slowed reaction times.

Eriksen and Eriksen concluded that the presence of other letters around a target letter increases the time it takes for subjects to correctly identify a target letter, even when the target letter is in the same position for each trial. The researchers determined that the results of the experiment were a product of response competition or interference. The subjects must be able to inhibit responses towards the incorrect letters in the sequence as the letters are processed simultaneously in order to choose the target letter.

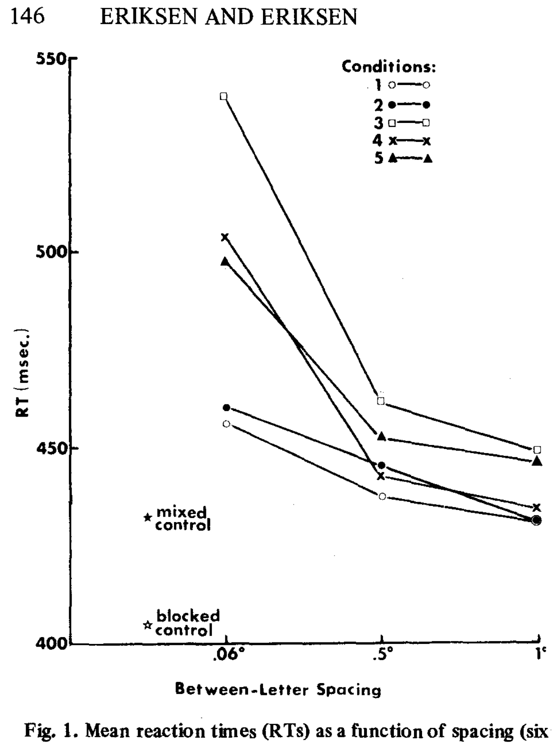

Figure 4: Results of mean reaction times for each condition of spacing (Eriksen & Eriksen, p. 146, figure 1)

Everling and Fischer (1997)

Another test of inhibition, similar to the one used in Miyake et al. (2000), is the antisaccades task. Everling and Fischer summarize research done using this task up until 1997. The antisaccade task involves a subject moving their eyes in the opposite direction of a visual stimulus. The first use of the antisaccade task was in 1978 by Peter Hallett. He found that reaction time for subjects during the antisaccade task was slower than for prosaccades, subjects moving their eyes in the same direction as the visual stimulus, and that there was more variation in the reaction times and velocities for the anti-task.

In relation to this study, Everling and Fischer state that the correct performance of the anti-task requires the ability to suppress reflexive saccades towards a visual stimulus and the ability to generate a voluntary saccade in the opposite direction of the visual stimulus. This often requires a corrective voluntary saccade after an initial prosaccade. Many children do not always correct errors after a primary prosaccade, which Everling and Fischer explain by stating children have a "lack of fixation activity" and that they cannot generate voluntary saccades. Research has shown the children under 10 are mostly not able to accurately perform the anti-task, though a paper written by Munoz et. al cites an improvement in the error rate between 6 and 15. This suggests that reflexive saccades develop by 10, but voluntary saccade development takes much longer.

This article concludes by stating that a high error rate in the antisaccade task suggests subjects are not able to inhibit reflexive saccades, and this fact can be used to assist in diagnosing various mental conditions. Regarding our study, this task of inhibiting the urge to look in a specific direction is comparable to Flanker and the Continuous Performance Task. Additionally, for our study, it is unclear whether children were able to accurately perform the antisaccade task as they were 6-7 years old, outside the generally accepted age-range for children able to generate voluntary saccades.

Munoz, Broughton, Goldring, & Armstrong (1998)

Munoz et al. also performed an experiment using prosaccade and antisaccade tasks. Their goal was to test the differences between performance on saccadic eye movement tasks based on age (5-79 years old). Two different conditions were used: an overlapping and gap condition with anti and pro saccadic targets. The overlapping condition consisted of a fixation point that remained lit up while the target appeared. The gap condition involved the fixation point being turned off, a gap of 200ms, and then the target appearing. The researchers found that the gap condition produces shorter reaction times than the overlap condition, the prosaccade had faster reaction times than the antisaccade, and placing the target on the right had shorter reaction times than the left.

In relation to age, the youngest group (5-8) had the highest percentage of express saccades in the overlap condition, largest gap effect, largest anti effect and most variable reaction times. The variance in reaction times and number of directional errors decreased as age increased to 20. The age group 18-22 had the shortest reaction times. The elderly group (60-80) had greater reaction times than the group aged 20-40. Munoz et. al describes these differences between younger and older age groups as relating to various portions of the brain, the main one being the frontal lobe. They stated the lower reaction times and greater variance in the youngest group could be explained based on less frontal lobe development. A spurt in frontal lobe development occurs around age 10, which could explain why reaction times get faster and more consistent with age. This would also explain why younger children's executive function abilities, such as inhibition, are poorer than adults' executive function abilities.

To summarize our review of literature on executive function and inhibition, executive function abilities take time to develop in children. Inhibition is an executive function ability that takes past the age of 10 to develop, and which can be measured in various ways. This study utilizes the Continuous Performance, Flanker, and Anti-Saccades Tasks to determine inhibition ability. Because executive function is stronger in adults, we will now review literature on the effects of executive function in adult and child language.

Executive Function and Adult Language

De Neys and Schaeken (2007)

In this study pertaining to executive function, De Neys and Schaeken conducted an experiment testing working memory ability and its relationship to pragmatic sentence interpretation. The participants, 56 college psychology students, were shown a dot pattern to memorize and, at the same time, asked to say whether sentences were true. The sentences were structured “Some…are…”. They were shown 10 filler sentences, such as “Some birds are eagles”, and 10 underinformative sentences, such as “Some tuna are fish”, while memorizing either easy dot patterns or complex dot patterns. The participants responded correctly to 94% of the complex dot patterns and 97% of the simple dot patterns.

De Neys and Schaeken found that sentence acceptance and correct responses on dot patterns were not related. Additionally, the participants interpreted 76% of the sentences as pragmatic, but made fewer pragmatic interpretations when they had to memorize complex dot patterns, which implies participants were responding more logically (less implicature generation), and more automatically, when they had to exert more effort. De Neys and Schaeken concluded that their results supported the theory that implicatures are not made automatically but take cognitive effort, which they suggest shows making scalar implicatures is linked to executive function abilities in that the use of one affects the outcome of the other. In regard to this study, we look at the quantifier *some*, which can be generated with an implicature.

Marty, Chemla & Spector (2013)

Another study analyzing the effect of memory is this study done by Marty, Chemla, and Spector, which investigated the effect memory load has on the interpretations of sentences with the quantifier *some* and sentences with numerical quantifiers. The participants were 26 native speakers of French, ages 19-34. In their experiment, participants completed a dual task that involved memorizing a sequence of letters while matching sentences to corresponding pictures. The sentences either contained *some*, i.e. “Some dots are red,” or a “bare numeral,” i.e. “4 dots are red.” The letter sequences were divided into two categories, low load and high load. The low load group only consisted of sequences with two letters, and the high load group consisted of sequences with four letters. Marty et al. found that the type of category of letter sequence had no effect on the accuracy of interpretation of unambiguous sentences, such as those containing *more than* or *fewer than.* They did find a significant difference in the effect the high load memory sequence had on interpretations of sentences containing *some* and a number. For *some*, fewer strong interpretations, i.e. *some but not all*, occurred in the high load group, but for bare numeral, the exact/strong interpretation occurred more often. Marty et al. concluded that these findings imply that the exact reading of numbers necessitates less memory relative to the *at least* number interpretation, and the *some but not all* interpretation of *some* requires additional memory. Lastly, Marty et al. also concluded that the vagueness that can occur in sentences with bare numerals or standard scalars, such as *some*, are processed in the brain by different means. This study is further evidence that implicature generation might involve executive function, which is required to accurately interpret sentences containing quantifiers such as *some*.

This review of some of the minimal literature on executive function and adult implicature interpretation demonstrates the idea that implicature generation is not an automatic function of the brain, but that rather, some kind of executive function ability is required. Now, we will review the relationship between executive function and child language.

Executive Function and Child Language

Kapa and Colombo (2014)

To look at the relationship between executive function abilities and language acquisition, Kapa and Colombo conducted an experiment with both adults and children to investigate whether executive function abilities would be predictive of success in second language acquisition. In order to test this, they administered various executive function tasks, as well as created an artificial language based on one created by Hudson, Kam, and Newport (2005) consisting of twelve nouns and four verbs with 528 possible sentence combinations in the order of verb-noun1-noun2.

In the first study, their participants were 87 undergraduate students. In order to teach the artificial language, participants were shown training videos and picture books. The tasks they administered to the participants were the Peabody Picture Vocabulary Test (PPVT), the digit span tasks, which tested working memory, the visual Simon task and Attention Network Task (ANT), which both tested inhibition, and the Wisconsin Card Sorting Task, which tested shifting ability. Kapa and Colombo were able to conclude that the adult participants learned the artificial language, and those with higher PPVT scores and digit span task scores were more successful in acquiring the artificial language. Additionally, the ANT score was a strong negative predictor of language acquisition, meaning those with lower ANT scores had higher inhibition abilities and greater acquisitional success.

In the second study, the participants were 44 children between 4:0 and 5:11. The children were also given the PPVT, digit span, visual Simon task, and ANT tasks, as well as the dimensional change card sort task (DCCS). The only significant executive function predictor of artificial language outcome was the DCCS task, which suggests higher attention shifting abilities in kids can predict higher artificial language acquisition.

Kapa and Colombo concluded that the reason inhibition abilities in adults were predictive of artificial language outcomes, but attention shifting was predictive for kids could be because adults use translation from English to understand the artificial language more than children do. In this sense, adults would have to inhibit the English translation for the second language more than children would have to because Kapa and Colombo suggest that children attributed two labels to words they were taught, one in English and one in the artificial language, which requires more attention shifting abilities. As language development continues in children, they become more adult-like in their interpretations, which suggests as children get older, they use inhibition more often.

Janssens et al. (2014)

Janssens et al. conducted experiments to test the effects of age and working memory on pragmatic interpretations of various sentences containing quantifiers. In their first experiment, they focused on whether age would affect pragmatic responses in 3 and 5-year-old children. The children were given a Truth Value Judgment Task and Action-Based Task to test their acceptance of pragmatic and logical interpretations of sentences with *some* compared to *all* and *none*. Janssens et al. found that age does affect “pragmatic competence” in that 5-year-olds were more likely to accept the pragmatic interpretation than 3-year-olds.

In the second experiment, the researchers tested whether working memory capability would affect the number of pragmatic responses in 5-year-olds. In addition to administering the same TVJT and ABT, Janssens at al. administered 3 working memory tasks. Though they did not find a significant result regarding the effect of working memory on pragmatic interpretations, Janssens et al. did find that the group with higher working memory skills was more accurate than the group with lower skills.

Lastly, Janssens et al. conducted an experiment with 7-year-olds to test whether they were more pragmatic than both the 5 and 3-year-olds. The participants were given the same TVJT, ABT, and working memory tasks, in addition to a world-knowledge TVJT to test whether the make-up of the tasks influences the logical and pragmatic interpretations. The world-knowledge TVJT yielded significantly fewer pragmatic answers than the other TVJT and ABT, and working memory was also found not to play a significant role in pragmatic interpretation.

Overall, Janssens et al. found that age does influence implicature production in that the older children get, the more likely they are to produce a pragmatic interpretation of a sentence. They also did not find significant differences between the high working memory span groups and low working memory span groups in any of their experiments, suggesting working memory might not play a role in quantifier interpretation.

Concluding our review of literature on executive function and child language, it is apparent that as children get older, the more adult-like they become in their interpretations of sentences containing quantifiers. These studies have also demonstrated that executive function abilities most likely play a role in the acquisition of language. Related to this idea, previous research has shown that bilingual children have higher inhibition abilities than monolingual children (Bialystok and Martin 2004). For this study, we were interested in investigating whether bidialectal children would behave in the same manner, in that these individuals might also need to "code-switch" between their two dialects. The following is a review of literature pertaining to dialectal variation in children.

Dialectal Variation

Washington and Craig (1998)

In one of the first studies looking at child African American English, Washington and Craig researched the differences between child dialect, gender, and socioeconomic status. The sample consisted of 66 African American children, ranging from 63 months to 76 months. In order to test the dialectal variation of the participants, an examiner was paired with a child, and they played for about 20 minutes while their conversation was recorded. Washington and Craig found a significant difference between gender and dialect, as well as between socioeconomic status and dialect, where dialect was analyzed by the number of AAE types (i.e. zero copula) in the first 50 communication units. Boys and children from the low SES groups had higher frequencies of African American English than girls and children from the middle SES groups.

The researchers suggested two possible reasons for this finding. One is that girls and individuals from middle SES groups have more mobility in that they are exposed more to "standard" American English, whereas boys and individuals from lower SES may not be exposed to it as much. An additional theory they propose is that there is a socialization process that takes place which encourages the increased frequency in dialect for boys, but lesser for girls. Washington and Craig conclude this study by stating how differences in dialect cause differences in speech and can often be a reason for misdiagnosis of speech and language problems in children. Therefore, it is important to keep these dialectal variations in mind whenever looking at differences in speech and language patterns.

Charity et al. (2004)

Similar to the above study, Charity et al. looked at African American English dialectal variation in children. They investigated whether familiarity with what they called “School English” (mainstream English) is related to reading comprehension in children. The sample consisted of 217 children from kindergarten to second grade in Cleveland, Washington D.C., and New Orleans. This was done during a professional development project for public school teachers involving improvement of reading instruction, in which multiple measures of reading achievement, sentence imitation, and story recall were performed. Three summary scores were obtained at the end of the study: phonological, grammatical and memory.

Charity et al. found that reading achievement did correlate with familiarity with School English (SE), but not with the memory score. This means that children with a higher familiarity with SE had higher reading achievements, which were not attributable to their memory skill. Charity et al. also suggested that familiarity with SE might be related to socioeconomic status, as did Washington and Craig (1998), or that these differences could be related to location, meaning that in states where the mainstream dialect is not consistent with Mainstream American English, children will have far less exposure to SE.

In order to explain these findings in reading achievement, Charity et al. described a few different hypotheses. One was that instructional quality and teacher bias could be an explanation. Another was linguistic interference, meaning a child’s main dialect, the one they hear the most often, would interfere with SE and their ability to comprehend the written form of SE, i.e. some letters they do not pronounce when they speak are included in the spelling of a word. Lastly, they suggested metalinguistic awareness might improve reading achievements. This means if a child is aware that their spoken English is not the same dialect as SE, they will have a higher reading achievement than those that are not aware of the dialectal differences.

Overall, this study demonstrates grammatical and phonological differences across dialect, however, they show that an important executive function ability, working memory, was not different across dialect groups.

Edwards et al. (2014)

In this study, Edwards et al. researched a theory, one that was mentioned in the above Charity et al. study, that child awareness of Mainstream American English (MAE) might improve their understanding of MAE. The study consisted of 83 AAE-speakers ranging from 4-8 years old. Two tasks were performed: the dialect awareness task and the comprehension task. In addition to these tasks, the dialect density of the participants was also measured from a 50-utterance language sample. In the dialect awareness task, several red or blue monsters were animated speaking sentences in either MAE or AAE. For each participant, either the red or the blue monsters spoke MAE and the other spoke AAE. Participants were supposed to generalize one color of monster as speaking only AAE or MAE. Edwards et al. found that children that were older and children that had a higher vocabulary were more accurate at identifying which monster spoke which dialect. Dialect density was also found to not be a significant predictor in this task.

In the comprehension task, two differences between MAE and AAE were used. One was a phonological contrast in which the final consonant of a constant cluster was deleted, which occurs more often in AAE than MAE (i.e. *coal* could mean *cold*). The other was a morphological contrast in that the plural *s* is not necessary in AAE, whereas it is in MAE (i.e. *cat* instead of *cats*). Participants were instructed to point to the picture that matched the word. Like the dialect awareness task, participants with a higher vocabulary were more accurate. Unlike the dialect task, Edwards et al. found that dialect density was predictive of the accuracy; participants with a high dialect density were less accurate.

Edwards et al. concluded that children with higher vocabulary skills might be better at identifying dialect shifting. They also theorized that children might be better able to learn to dialect shift when they have higher linguistic and metalinguistic skills, meaning they might be able to identify the differences between the two dialects and shift more readily between them. Like the previous research mentioned, this study indicates that dialect variation causes differences in grammatical, morphological, and phonological aspects of language.

Global Summary

To summarize this literature review, it has been found that it takes children until the age of 10 or older to interpret sentences containing collective and distributive quantifiers in an adult-like manner. Children often accept the distributive quantifier *each* in a collective context and the collective quantifier *some* in a distributive context. Additionally, there has been evidence that executive function, and specifically inhibition for this study, might influence this phenomenon. In research done with adults and working memory span, it is often harder for adults to access the implicature for *some* (i.e. *some, but not all*) if they are using more of their working memory. In studies done with children, children who have higher executive function abilities are often able to access a more adult-like interpretation of collective and distributive sentences than those with lower executive function abilities. Finally, in research done with bidialectal children, there is evidence to show that these children may need to switch between their two dialects, which can affect grammar, morphology, and phonology, but there is no evidence to show this affects executive function. These ideas lead us into our research questions.

Research Questions

1. Are individual tests of inhibition predictive of collective distributive interpretations?
2. Are there differences between mainstream vs. non-mainstream dialects of child English with respect to collective-distributive interpretations?
3. Are there differences between dialect groups with respect to inhibition?

Methodology

Participants

The sample for this experiment is made up of 35 monolingual English-speaking children from various central Ohio after-school and summer camp programs. There were 19 females and 16 males ranging from 71 months (5.9 years) to 94 months (7.8 years) with a mean of 82.1 months (6.8 years) and standard deviation of 6.87 months.

Procedures

Before participants were given any tasks to perform, parents were asked to sign a university IRB-approved consent form and to fill out a questionnaire pertaining to the child's language development. If the participant heard no other language besides English on a frequent basis, had no speech, hearing, or language problems, and no family history of these problems, as well as no developmental concerns, they could participate in this study. 9 children were excluded for being multilingual and 4 children were excluded for speech or language problems.

After the questionnaire, participants were given the Truth Value Judgement Task (TVJT), which was used as our measure of collective and distributive interpretations. The TVJT consists of 32 short stop-motion videos in which minions or monsters are performing some task on a farm. They are either working together (collectively) or individually (distributively). As the videos play, they are narrated by a woman's voice. An example of the narration is "The minions are working on the farm, and they have to plant some trees. There's only one. How are they going to do it?... I know how they did it! Some minions planted a tree."

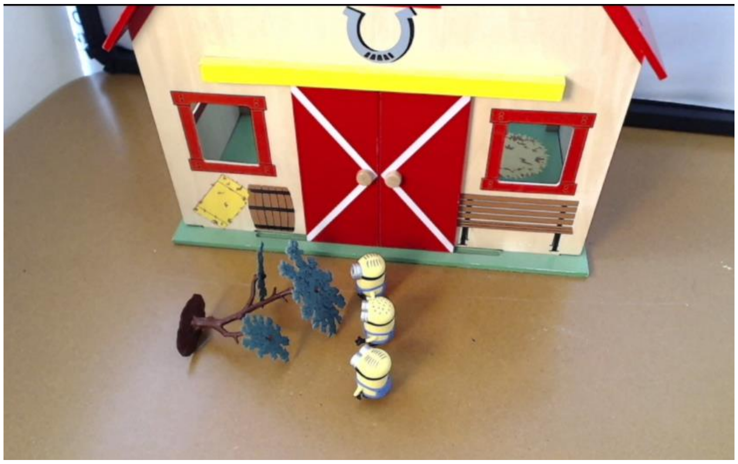

Figure 5: Example of visual stimulus of collective action in the TVJT

The TVJT consists of 32 experimental videos, which are divided into several categories. There are 4 practice videos that are not a part of the target videos, 12 filler videos, 5 videos containing the collective quantifier *some* with the collective action, 5 with *some* in a distributive context, 5 containing the distributive quantifier *each* with the distributive action, and 5 with *each* in a collective context. These videos were randomized each time, with only the 4 practice videos remaining in the same order at the beginning of the experiment.

The next set of tasks were administered from the EXAMINER battery (Kramer et al. 2014). The three tasks administered all tested the executive function ability, Inhibition. The first task is called the Flanker task in which a row of fishes appears on the computer screen. Participants were instructed to focus on the middle fish and press the left or right arrow key corresponding to the direction the fish was facing. The middle fish was either congruent or incongruent, meaning it faced in the same direction as the surrounding fish or faced in the opposite direction.

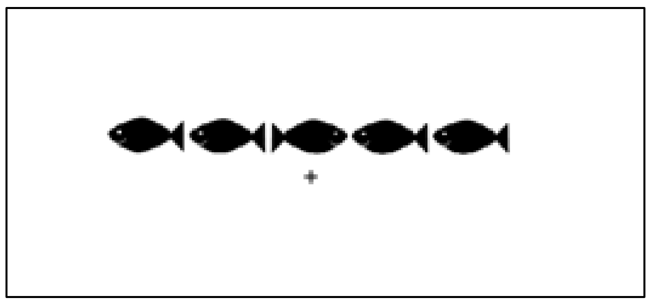

Figure 6: Flanker Stimulus

The next EXAMINER task is called the Continuous Performance Task. In this task, participants were instructed to press the left arrow key only in response to a 5-pointed star target stimulus. If any other shape popped up, the participants were instructed to not press anything.

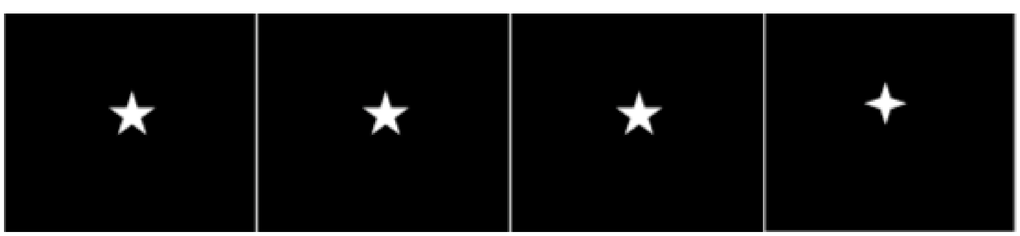

Figure 7: Continuous Performance Task Stimulus

Lastly, the Anti-Saccades task was the final test of Inhibition. In this task, a dot would appear on either side of the screen, and participants had to look in the opposite direction of the dot. A short practice containing 3 trials was given before both full sets of 20 trials.

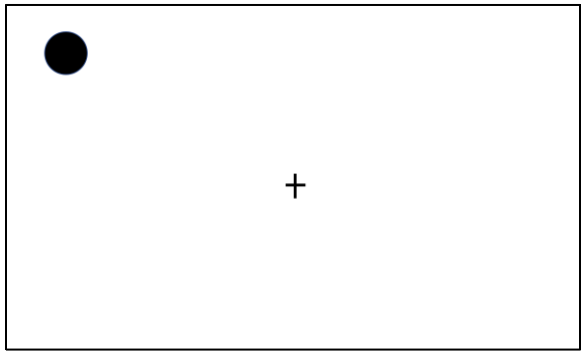

Figure 8: Anti-Saccades Stimulus

The last test administered to participants is called the Diagnostic Evaluation of Language Variation (DELV). This categorized the child's English into Mainstream American English, Some Variation from MAE, and Strong Variation from MAE by looking at the use of 3rd person singular have/has, -s/-es, do/does, the copula, was/were as well as phonological features.

Results

	***Each* Collective**	***Some* Distributive**	**Flanker**	**Continuous Performance Task**	**Anti-Saccades**	**Maternal Level of Education (years)**
Mean	2.686	3.857	3.239	2.375	26.031	16.526
Standard Deviation	2.083	2.158	1.028	0.972	8.220	1.836

Table 4: Mean and standard deviation of TVJT scores, Examiner scores, and maternal level of education

The mean number of acceptances for *each* in the collective context was 2.686 with a standard deviation of 2.083. The mean number of acceptances for *some* in a distributive context was 3.857 with a standard deviation of 2.158.

In order to control for the yes bias in the Flanker and Continuous Performance Task scores, d-prime calculations were used. D-prime scores allow us to analyze the number of false alarm acceptances and the number of target correct responses, as well as consider response bias.

A higher d-prime score corresponds to a higher accuracy, meaning a participant accepted fewer false alarms. The average d-prime score for the Flanker task was 3.239 with a standard deviation of 1.028, and the average for the Continuous Performance Task was 2.375 with a standard deviation of 0.972.

The anti-saccades score was determined by the number of glances in the correct direction. The average number of correct glances was 26.031 with a standard deviation of 8.220. It is important to note that our participants were outside the generally accepted age-range for individuals able to accurately perform this task. Though our participants seemed to understand the task and what they were supposed to do, it was evident that often they were unable to generate a voluntary saccade to look in the opposite direction of the stimulus, but rather automatically looked at the stimulus, even though they were aware this was an incorrect response.

With the rest of these results, we were able to find various significant relationships. As we expected, the older children were, the less they accepted *some* in a distributive context ($R = -.445$, $p = .007$, $n = 35$).

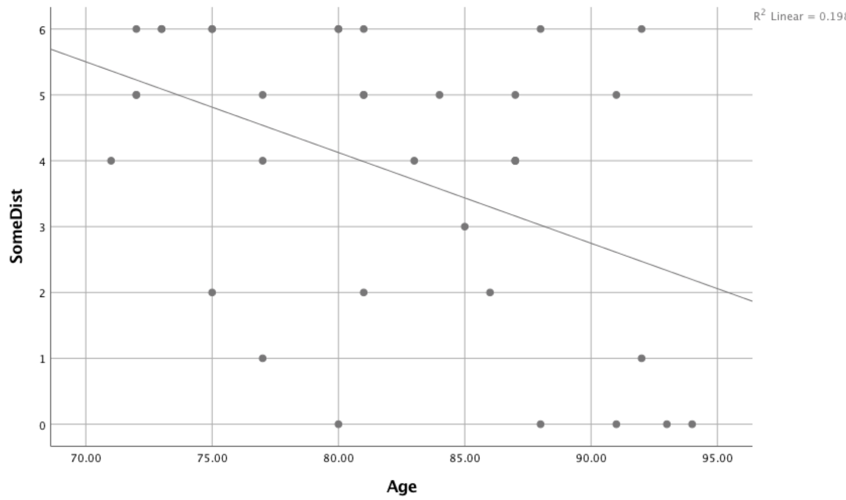

Figure 9: Acceptance of *some* in distributive context compared
to age in months

Additionally, acceptance of distributive *each* in collective contexts predicts acceptance of collective *some* in distributive contexts (B = .538, SE = .154, p = .001), as in previous research in Spanish and English, supporting Dotlačil's (2010) view of these quantifiers as members of a collective-distributive pragmatic lexical scale.

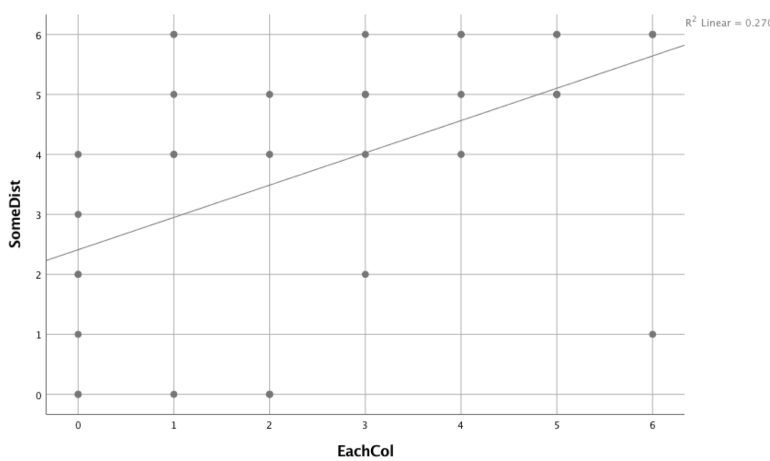

Figure 9: Acceptance of *some* in distributive context compared to acceptance of *each*
in collective contexts

Further, as in Oates (2017), acceptance of *each* in collective contexts and Continuous Performance d-prime scores are predictive, in a multiple regression, of acceptance of *some* in distributive contexts (r^2 = .316 for the entire model; for each, B = .508, SE = .147, p = .001; for CP, B = -.294, SE = .315, p = .047). CPT is not predictive of each in collective contexts, however (p > .05).

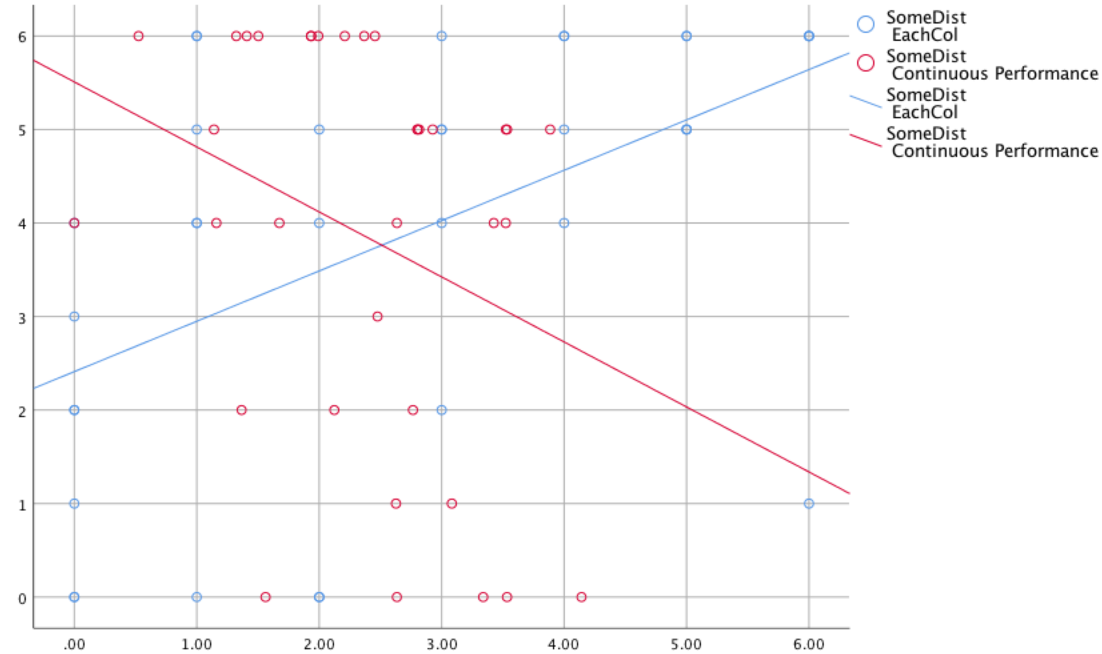

Figure 10: Multiple regression of acceptance of *some* in distributive context, *each* in collective context, and CPT d-prime scores

Also, children are significantly different from one another as a function of English dialect, using the 3 dialect categories of the DELV in a one-way ANOVA, and the mean number of acceptances of *some* in a distributive context (F(2,28) = 3.667, p = .039). Given the small number of children in the Strong Variation category (n=2), however, we can collapse the two variation categories into one and see more significant differences, in an independent samples t-test (t(29) = -4.056, p < .001). It is important to note that these two groups are not significantly different from one another in age (t(29) = .683, p = .507).

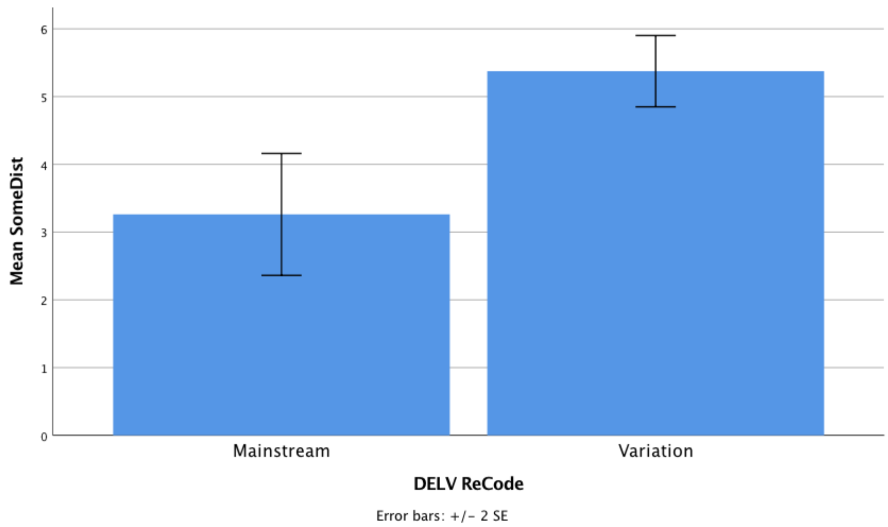

Figure 11: Mean acceptance of *some* in distributive context as function of dialectal variation

Furthermore, given the predictive relationship between *each* and *some*, it is noteworthy that acceptance of *each* in collective contexts is also significantly different across the two dialect groups (t(29) = -4.208, $p < .001$).

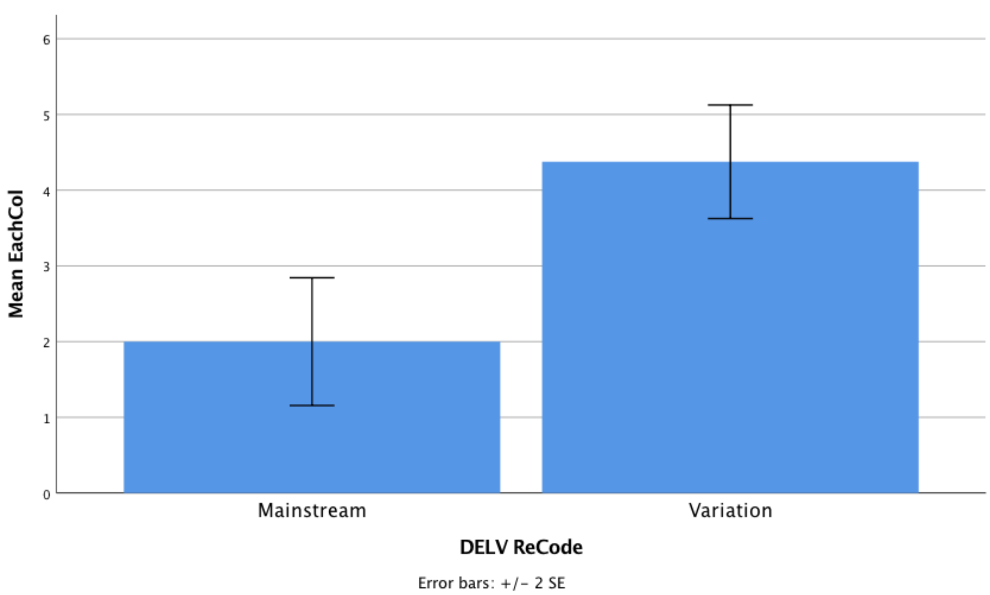

Figure 12: Mean acceptance of *each* in collective context as function of dialectal variation

Lastly, the two dialect groups (variation, n = 8; mainstream, n = 23) are not significantly different from one another on any of the three measures of inhibition ($p > .05$).

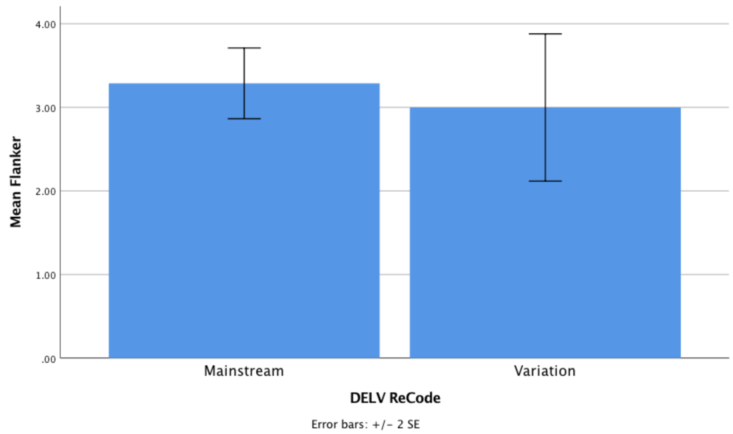

Figure 13: Mean Flanker score as function of dialectal variation

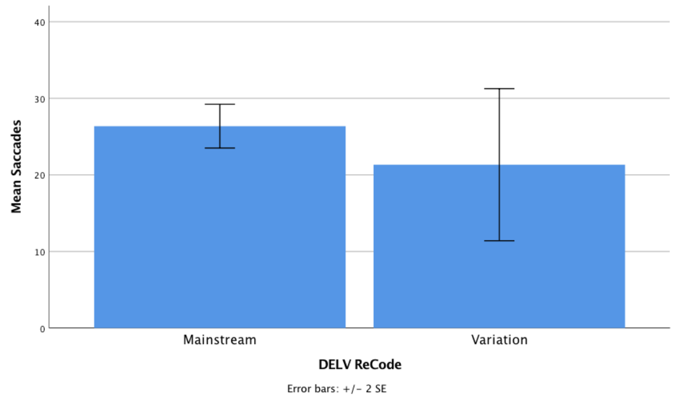

Figure 14: Mean CPT score as function of dialectal variation

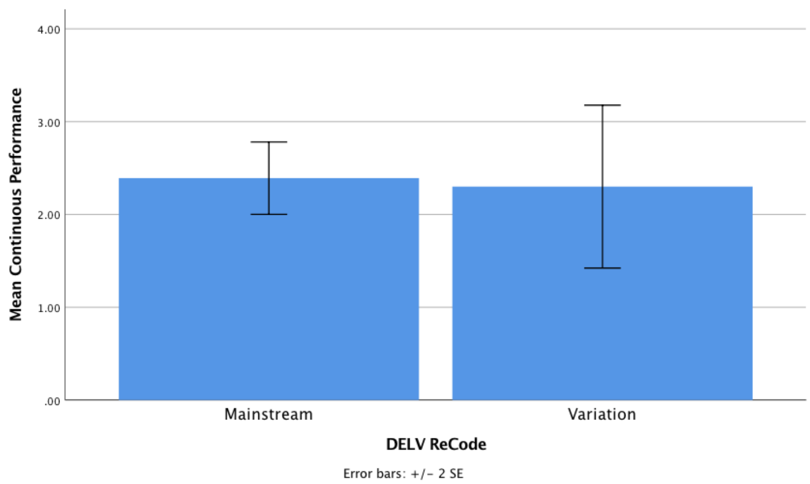

Figure 15: Mean Anti-saccades score as function of dialectal variation

Discussion

These results confirm the findings of previous literature in that the older children were, the less they accepted *some* in the distributive context. This shows that as children become older, their interpretations of sentences become more adult-like. Additionally, because accepting *each* in collective contexts predicted acceptance of *some* in distributive contexts, there is further evidence that these quantifiers lie on a pragmatic lexical scale of collectivity-distributivity, as per

Dotlačil (2010). The more children understand the distributive nature of *each*, the more they derive an exclusively collective interpretation of the other plural quantifiers on the scale, including *some*. In this way, *each* serves as an anchor for the meanings of the others.

We also found that the CPT d-primes scores, along with the acceptance of *each* in collective contexts, predicted the acceptance of *some* in distributive contexts. This means that individuals with higher inhibition skills (higher CPT scores) were more able to access the implicature associated with *some* and were, therefore, more adult-like in their interpretations of these sentences. This indicates that inhibition might play a role in the acquisition of these collective-distributive quantifiers, confirming the findings of Oates (2017), which were obtained using a different measure of inhibition, the Flanker Task.

Lastly, looking at the significant differences between the acceptance of *some* in distributive contexts and the acceptance of *each* in the collective contexts amongst the two dialectal variation groups, we can conclude that the differences are not attributable to the inhibition component of executive function. There was no significant difference between any of the inhibition scores amongst the dialectal variation groups, so the distinction in collective-distributive interpretations is not attributable to inhibition. Because lexicon has been predictive in the past of this distinction, and because bilingual children many times acquire each of their lexicons a bit more slowly than do monolingual children, it could be the case that bidialectal children are also somewhat slower to acquire their multiple lexicons, though this is strictly speculative, as we did not measure lexicon.

Conclusion

With these results in mind, we conclude tentatively that inhibition of the potentially distributive meaning of *some* may be an important dimension of the pragmatic reasoning underlying scalar implicature interpretations. As children's inhibition abilities develop, the more adult-like they should be in their interpretations of collective and distributive sentences. Additionally, bi-dialectal children, on analogy with bilingual children, may take a bit more time to develop their lexicons, including the scalar relations among their collective-distributive quantifiers. There is no evidence, though, that dialectal variation determines the cognitive ability, inhibition, in our sample.

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Appendices

Language Development

Basic Information

First Name and Surnames of the child:______________________ Date of Birth: _____

First Name and Surnames of the parent/guardian (mother or father)________________

Total Number of Years in School:_____________

First Name and Surnames of the parent/guardian (mother or father)________________

Total Number of Years in School:_____________

Development

1. Did anything unusual occur with the pregnancy or birth?

If so, what was it?__________________________ _____________

Child's birth weight: ___________________________________

Were there problems after birth?___________________________

2. At what age did your child first reach these milestones?

Sat alone__________________ Stood alone_____________ ___

First words________________ Combined words____________

Potty trained_______________ Walked alone______________

3. Do you have any concerns about your child's development? Yes No

If so, what?____ ___________

____

4. Hearing

Does your child have hearing problems? Yes No I don't know.

Has your child had ear infections? Yes No I don't know.

5. Language

Does your child hear any language other than Spanish on a regular basis? Yes No

If so, what language is it and how frequently?___________________________

Do you have any concerns about the development of your child's speech or language? Yes No

If so, what are they? ____

Does your child have a history of problems with speech or language? Yes No

Has your child's speech or language ever been formally assessed? Yes No

If so, when and what for?____

Is there a history of speech or language delays or problems in your family? Yes No

If so, what kind?____

What is the relationship of the person(s) with the problem(s) to your child?_______

Part I Language Variation Status

Repetition Rule: Repeat the item once if the child does not respond or if the child requests it. If the child does not respond after repetition of the item circle NR for "No Response" and proceed to the next item.

Materials: Stimulus Book; see Examiner's Manual for complete administration and scoring directions.

Introduction: When you introduce the test to the child, say: **Most people think that talking is fun. Today I'm going to give you a test about talking that has been made for children just like you. Lots of the pictures I'm going to show you and stories I'm going to tell you are about children or people just like you. Some of the test is for older children and may be hard for you. Some of the test is for younger children and may be easy for you. Sometimes I'll say things that are funny or hard to understand, but most of the time you'll be able to figure out the answer because it's easy. When we finish this test tell me how you liked it. Let's begin!**

Recording/Scoring: Circle the word that matches the child's production of the target word/target phoneme (indicated in **green** type). Use the "Other" column to record any production not listed in columns A or B. Calculate the subtotals by adding the number of responses in columns A and B only.

Partial Response Rule: See Examiner's Manual

Trial Item A: Turn to the page in the Stimulus Book marked Part I Language Variation Status. Say: **I'm going to show you some pictures and tell you what I see. Then I want you to say exactly what I said. Let's try one.** Turn to the page marked Part I—Trial Item A and Items 1-5. Point to the picture in the upper left-hand corner of the page and say: **I see a man.** If the child imitates your sentence exactly, say: **Good. Let's do some more.** If a child does not imitate the sentence exactly, say: **Let's try that again. Say what I say. I see a man. You say it.** Prior to the test session review the Examiner's Manual for instruction on what to do if a child does not imitate your sentence. Proceed to Item 1.

Item Point to each picture and say:	A	B	C	D
1. **I see her brushing her teeth.**	teef	teeth	Other: ________	NR
2. **I see a bird taking a bath.**	baf	bath	Other: ________	NR
3. **I see a smooth table.**	smoov/smoo	smooth	Other: ________	NR
4. **I see that fish breathe under water.**	breave/breade	breathe	Other: ________	NR
5. **I see a gift near the baby.**	gif	gift	Other: ________	NR
Subtotals for Items 1-5				

Recording/Scoring: The verb or verb form being assessed is listed in the green bar above each set of items, as are the criteria for deciding if a response belongs in column A, B, or C. Circle the answer that corresponds with the verb form the child uses. If the child responds with another verb, look at the criteria in the green bar or see Appendix A to determine where the response belongs. Calculate the subtotals by adding the number of responses in columns A and B only.

Trial Item B: Say: **Now I'm going to show you some more pictures and tell you something about each one. I want you to look at the pictures and finish what I say about them. Let's try one.** Turn to Trial Item B in the Stimulus Book. Direct the child's attention by pointing to the pictures as instructed in parentheses. Say the **boldfaced** words and emphasize the *italicized* words. (Point to the hay.) **I see hay.** (Point to the carrots.) **I see carrots.** (Point to the horses.) **The *horses* eat hay,** (Point to the rabbit.) **but the *rabbit* . . .** (eat/eats carrots). If the child completes Trial Item B appropriately by providing a verb, turn to the page marked Item 6 and continue testing. Prior to the test session review the Examiner's Manual for instruction on what to do if a child does not provide a verb or if a child uses a plural subject.

Item	A	B	C	D
3rd Person Singular Have/Has. Response includes the verb:	**have or got**	**has**	**something else**	**NR**
6. (Point to the little kites.) **I see little kites.** (Point to the big kite.) **I see a big kite.** (Point to the boys.) **The *boys* have little kites,** (Point to the girl.) **but the *girl* . . .**	have got	has	big kite(s) ________	NR
7. (Point to the dogs' tails.) **I see short tails.** (Point to the cat's tail.) **I see a long tail.** (Point to the dogs.) **The *dogs* have short tails,** (Point to the cat.) **but the *cat* . . .**	have got	has	long tail(s) ________	NR

3rd Person Singular -s, -es. Response includes a verb:	without -s, -es	with -s, -es	something else	NR
8. (Point to the sleeping bags.) **I see sleeping bags.** (Point to the bed.) **I see a bed.** (Point to the boys.) **The *boys* always sleep in sleeping bags,** (Point to the girl.) **but the *girl* always . . .**	sleep	sleeps	in bed	NR
9. (Point to the horses.) **I see horses.** (Point to the bike.) **I see a bike.** (Point to the girls.) **The *girls* always ride horses,** (Point to the boy.) **but the *boy* always . . .**	ride	rides	a bike riding a bike	NR
10. (Point to the plates.) **I see plates.** (Point to the glasses.) **I see glasses.** (Point to the boys.) **The *boys* always wash the plates,** (Point to the girl.) **but the *girl* always . . .**	wash clean	washes cleans	cups/glasses washed the glasses	NR
11. (Point to the wagon.) **I see a wagon.** (Point to the stroller.) **I see a stroller.** (Point to the girls.) **The *girls* always push the wagon,** (Point to the mom.) **but the *mom* always . . .**	push	pushes	stroller	NR
3rd Person Singular Do/Does. Response includes the verb:	do	does	something else	NR
12. (Point to the girl.) **This *girl* likes to swim,** (Point to the boy and shake your head to indicate "no.") **but this *boy* . . .**	don't do not	doesn't does not	likes to stand	NR
13. (Point to the boy.) **This *boy* likes to play basketball,** (Point to the girl and shake your head to indicate "no.") **but this *girl* . . .**	don't do not	doesn't does not	likes to watch	NR
Subtotals for Items 6–13				

Trial Item C: Say: **Now I want you to answer my questions. Let's try one.** Turn to Trial Item C. (Point to the picture of the dog standing on its hind legs.) Say: **Look at the dog. Why is the dog standing on his back legs?** (To get food.) If the child completes Trial Item C appropriately by answering the question, say: **Now let's do some more.** Turn to Item 14 in the Stimulus Book and continue testing. Prior to the test session review the Examiner's Manual for instruction on what to do if a child does not appropriately answer the trial question or does not use a plural subject.

Copula (or Auxiliary) Was, Were. Response includes a plural subject plus:	was	were	something else	NR
14. (Point to the dirty clothes in the basket on the left.) **See the lady with the clothes. She said the clothes needed to be washed. So she washed them.** (Point to the washed clothes on the clothes line.) **Why did she wash these clothes?**	They was	They were	They dirty It was dirty	NR
15. (Point to the picture on the left.) **These girls couldn't get out of bed, and their mother gave them some medicine.** (Point to the picture on the right.) **Today, they are not sick.** (Point to the picture on the left again.) **Why did their mother give them medicine *yesterday*?**	They was	They were	They sick She was sick	NR
Subtotals for Items 14–15				
	A	B		
Part I Totals for Items 1–15				

Note: See the Examiner's Manual for more examples of column A, B, and C responses.